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Serial No.: 10/812,467 **Office Action Date:** 4/30/2007
Filing Date.: 3/30/2004 **Amendment Date:** 7/27/2007

IV. REMARKS/ARGUMENTS

This is a response to the Office Action issued on May 3, 2007. Claims 1, 10-18, 27-36 are pending in this application. Claims 1, 10-11, 13-17, and 27-36 stand rejected. By this response to the Office Action, claim 1 has been amended. Claim 12 has been cancelled and rewritten in independent form as claim 39. New claims 37 and 38 have been added. Claims 18 and 39 stand in condition for allowance. No new matter has been added by response to the Office Action.

Consideration of claims 1, 10-11, 13-17, and 27-38 is respectfully requested.

Claim Rejections – 35 U.S.C. 102

Claims 1, 10, and 27-31 are rejected under 35 U.S.C. 102(e) as being anticipated by Litorell et al. USPN 6,609,364 (*Litorell*). Applicants respectfully traverse this rejection on the basis that Litorell fails to teach all elements taught in the claims of the present application, as is required under 35 U.S.C. 102(e).

Regarding claim 1, applicants respectfully assert that claim 1 is patently distinguishable over Litorell, because Litorell fails to teach or describe all of the elements of claim 1, as is required under 35 U.S.C. 102(e). Applicants respectfully point to the operating regions identified within the Office Action utilized by the Litorell method, and this response will describe in detail how these regions are not patently similar to the regions described in the present application under claim 1.

Claim 1 sets forth a method for controlling a direct injection internal combustion engine. Claim 1 goes on to define a first engine operating region and a second operating region. The first region of operation is further described in paragraph 0032 and in FIG. 3A as the area within line 300, comprising area 302 as strictly stratified operation, and 304, 306,

and 308 defining as stratified charge regions "transitioning from homogeneous." This band between the homogeneous zone outside line 300 and strictly stratified area 302 could be described as a transition zone in which the engine controller 30 may, permissively, initiate a regeneration event per the logic described in FIG. 2. It should be noted that claim 1 defines the first operating region as the only region in which stratified operation is possible. The specification goes on in paragraph 0033 to define terms under which, as portrayed in FIG. 3B, the regions allowing stratified operation are reduced to form a second operating region. Claim 1 includes in the definition of the second operating region that this second region consists of a "reduced portion of the first operating region." This reduced second operating region still encompasses the area within line 300, comprising areas 302, 304, 306, and 308. For reference, markups of FIGS. 3A and 3B are included below.

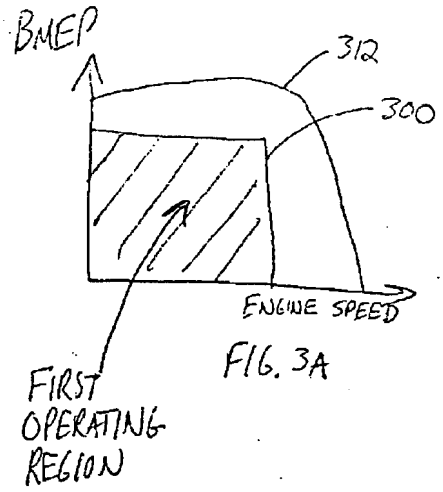


FIG. 3A

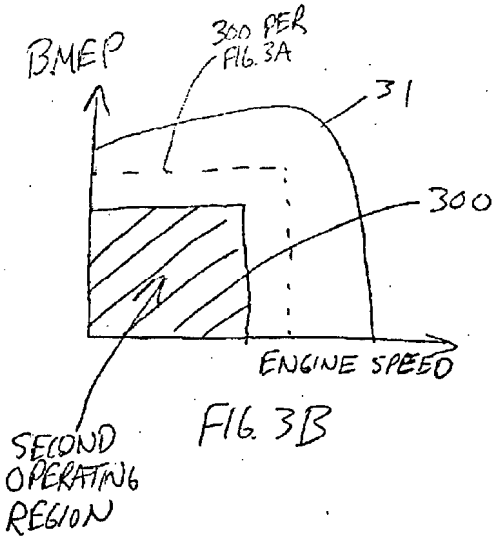
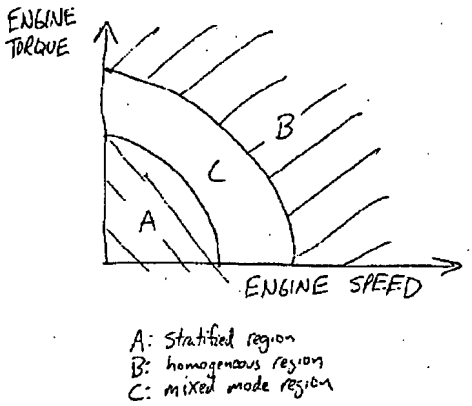


FIG. 3B

Support for the two regions in claim 1 being defined in this way may be found throughout the specification and in the subsequent elements of claim 1, in which the first region and the second region are described in combination with selecting modes of operation, as selected by

the NOx trap device holding less and more, respectively, than the NOx mass described by the first threshold. The elements describing this relationship of the regions to the modes of operation are important to understanding the distinction between claim 1 and Litorell and will be described herein.

The Office Action asserts that Litorell discloses the use of two patently similar operating regions: a first operating region being defined by a "stratified operating mode"; and a second defined by "switching from stratified to homogeneous operating mode." (Office Action, page 3.) While one could define two operative regions as such, applicants note that these operating regions are functionally different from the operating regions defined by claim 1. Litorell does, by function, describe three regions of operation: one region, of low torque and engine speed, requires operation in a stratified mode; another region, of high torque and engine speed, requires operation in a homogeneous mode; and any region in between is typically operated as a either or some mix of the two modes per a lookup table. (Litorell, col. 7, lines 24-43.) This scheme under Litorell defines a set of operating fixed operating bands defined by the lookup table which could be described as a stratified region, a mixed mode region, and a homogeneous region. A graphic depiction of these regions set up within Litorell is included below.



Litorell then incorporates a regenerative cycle by imposing upon any points capable of stratified operation a period of homogeneous operation (Litorell, col. 7, line 46 – col. 8, line 5.), however, exempting the region which requires operation in a stratified mode, designated as Zone A, above. (Litorell, col. 10, lines 9-15.). Zone B requires operation in a homogeneous mode and is, therefore, incapable of stratified operation. (Litorell, col. 10, lines 9-15.). Therefore, Litorell affects the regenerative cycle switching between operating modes, based on a timer feature (Litorell, col. 7, lines 54-60), in the mixed mode range defined between the areas of mandatory stratified and mandatory homogeneous operation, or zone C in the depiction above. Returning to the definition of operating regions pointed to by the Office Action as patently similar to the regions defined by claim 1, the definitions of the regions by the Office Action would create a first region as the stratified region plus the mixed mode region (zones A and C, in the depiction above) and a second region as the mixed mode region (zone C above).

The last element of claim 1 recites an element of the method claimed, including "operating the engine ***in the stratified charge combustion mode*** when the engine operation is ***within the second operating region*** and the cumulative mass of the NOx stores on the NOx

trap device is ***greater than the first threshold***" (emphasis added.) Zone C as depicted above, the transition region for Litorell and the second region defined by the Office Action, is the region in Litorell in which the regenerative cycle does take place when the NOx threshold is passed. The second region, the reduced area under line 300 in claim 1, is the region in which, by the last element of claim 1, the engine does not enter the regenerative cycle despite the first threshold having been passed. The definition of the second region within the Office Action is inconsistent with the regions defined within claim 1.

Additionally, it is noted that despite any apparent equivalence between Zone A as depicted above and the second region as defined in claim 1, these regions are in fact patently distinguishable. Zone A as depicted above for the Litorell invention, as previously described, is a zone in which homogeneous operation is not possible and is set by engine fuel mix requirements. This distinction is reinforced throughout the Litorell specification and is most clearly enunciated in column 10, lines 10 to 15, in which it is stated "[A] mode switch cannot occur until a certain limit has been fulfilled. This limit condition can be expressed... as a minimum lambda value that occurs in the stratified operating mode." This physical limit wherein stratified operation is highly preferred is based upon engine calibration results and is well known in the art, as described in paragraph 0007. This minimum lambda value defines this mandatory stratification area or zone A by specifically exempting it from the mixed mode zone. The Litorell specification describes the forced change in air/fuel mixture associated with the regenerative event, and this paragraph is enforcing the terms under which the forced event does not take place. The present invention, as described in paragraph 0011, instead, seeks to "[hasten] the entry into homogeneous region." This hastening of homogenous operation is enabled by the nature of the recession of line 300: where Litorell opens up the transitional area in a binary fashion (anything not protected as a mandated mode

is put through a regenerative cycle) the present invention moves line 300 and the associated transitory areas 304, 306, and 308 some level of engine operation lower. The invention enables a preference to stay in the fuel efficient stratified operation as long as is possible. This preference may be accomplished by only receding line 300 some portion of the way to the physical limit or by incrementally, gradually moving line 300 over multiple cycles of reduction. This gradual movement of line 300 is enabled in the specification, paragraph 0024: "It is envisioned that successive loops through the previously described steps 202 through 214 may result in incremental reductions of the stratified change region at block 212." Whether the recession of line 300 is partial or gradual, this selective recession of line 300 enables a fuel economy not enabled by the Litorell invention.

This partial or gradual recession of line 300 has the benefit of enabling the vehicle to de-prioritize the entry of the engine into homogeneous operation and improve fuel efficiency. Whereas Litorell's timing feature for the NOx regenerative cycle will force the expenditure of additional fuel associated with forced homogenous operation, the present invention enables the engine controller to wait a time to force a regenerative cycle. This feature enabling the controller to wait to initialize the regenerative cycle creates the opportunity for regular operation of the vehicle to accomplish what the forced regenerative cycle would accomplish. If, while the controller is waiting, either road conditions or operator torque requirements take the engine speed or load into the zones permitting regeneration, the added engine output will accomplish the regenerative cycle without expending extra fuel. If no such increase in engine activity occurs, either line 300 will gradually recede to a limit similar to Zone A depicted for the Litorell invention or the mass of the NOx stored in the NOx trap device will exceed the second threshold, triggering a regenerative cycle. In this way, fewer regenerative cycles will have to be forced, and fuel economy will be increased.

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While support related to the above distinguishing features as presently claimed in claim 1 currently exists throughout the specification, in interests of furthering prosecution and gaining approval of the application, applicants respectfully submit the following revisions to claim 1 in order to more distinctly describe the aforementioned features:

> 1. (Currently Amended) Method for controlling a direct injection internal combustion engine selectively operative in one of a homogeneous charge combustion mode and a stratified charge combustion mode and having an exhaust gas conduit fluidly connected to a NOx trap generally effective to accumulate NOx emissions during lean operation of the engine and to release said accumulated NOx emissions during rich operation of the engine comprising:
> defining a first engine operating region as the only region in which stratified charge combustion mode is enabled;
> defining a second operating region consisting of a reduced portion of the first operating region, the second operating region operative to redefine the only area in which stratified charge combustion mode is enabled;
> monitoring engine operation;
> determining a cumulative mass of NOx stored on the NOx trap device;
> operating the engine in the stratified charge combustion mode only when the engine operation is within the first operating region and the cumulative mass of NOx stored on the NOx trap device is less than a first threshold; and
> operating the engine in a stratified charge combustion mode when the engine operation is within the second operating region and the cumulative mass of the NOx stored on the NOx trap device is greater than the first threshold.

In light of the amendments made to claim 1 and the aforementioned distinguishing characteristics between Litorell invention and the present invention, applicants therefore respectfully assert that the disclosure of Litorell fail to teach every element of claim 10. In view of the claim amendments and the remarks herein above, applicants respectfully request reconsideration of the rejection of claim 1 set forth in the subject Office Action and that same be withdrawn.

Regarding claim 10, applicants respectfully assert that claim 10 is patently distinguishable over Litorell, because Litorell fails to teach or describe all of the elements of claim 10 as is required under 35 U.S.C. 102(e). Applicants respectfully point to the third element of claim 10 describing the reduction of the stratified charge operating region and respectfully traverse the interpretation within the Office Action the operation of this element.

Claim 10 presents a method for controlling regeneration of a NOx trap. The claim comprises a stratified charge operating region and reduces the size of this region when the accumulated NOx exceeds a first threshold value. The third element of this claim states the following regarding this reduction: "wherein reducing the stratified charge operating region comprises reducing engine speed and engine load at which to operate the engine in stratified charge mode." This element may be illustrated by again referring to FIGS. 3A and 3B. From paragraph 0031, these figures are said to illustrate a method comprising shrinking the stratified region of operation of an SIDI engine, where this shrinking of the stratified region is coupled with the effect of enlarging the homogeneous charge region of operation. Referring to the figures, the axes fix particular values of engine load and engine speed, and areas designated as stratified operation and homogeneous operation are plotted against these values. The above described element of claim 10 states that the region on the graph showing where stratified operation is possible will reduce, and it will correspond to lower engine speeds and lower engine loads. We see that line 300 in FIG. 3B is lower on the Y-axis than line 300 in FIG. 3A. This location on the Y-axis indicates that the region encompassed by line 300 in FIG. 3B includes lower BMEP or engine load values than the same region on FIG. 3A. We also see that line 300 in FIG. 3B is more to the left or lower on the X-axis than line 300 in FIG. 3A. This location on the X-axis indicates that the region encompassed by line 300 in FIG. 3B includes lower engine speed values than the same region on FIG. 3A. As

is enabled throughout the specification, the invention discloses the creation of a region in which the stratified operation of the engine is enabled, and then this region is reduced or an equivalent region of reduced size is created in order to restrict the engine conditions in which the engine may operate with fuel-air mix ratios indicative of stratified operation. Looking at FIG. 3A, one could define a point just to the left of the vertical line defining the boundary for line 300. In FIG. 3A, for this engine speed and engine load, this engine would be operating in stratified mode. For the same engine speed and engine load, after the NOx has accumulated past the first threshold, FIG. 3B shows us that the engine is now operating in homogeneous mode. In this way, the invention controls regeneration of the NOx trap.

The Office Action, in comparing Litorell to the present invention and find equivalent elements to claim 10, stated that Litorell accomplished the following:

> wherein reducing the stratified charge operating region comprises reducing engine speed and engine load at which to operate the engine in stratified charge operating mode (before switching to homogeneous charge operating condition (in step 29), ***an air flow is reduced (in step 27) which causes a reduction in engine speed and engine load***) (emphasis added). (Office Action, page 5.)

This statement, that an air flow reduction in the Litorell device causes a reduction in engine speed and engine load, neither addresses the step disclosed by the element, nor is it accurate of the operation of the Litorell device. As described above, this element of claim 10 describes the change of operating mode for a given engine speed and engine load within the affected reduced area or the area changed from stratified to homogeneous. No actual change in engine load or engine speed is implied. The invention merely adjusts the fuel-air mix at this state of operation to change the operating mode, keeping the engine speed and the engine load constant. Regarding the implication that the air flow in the Litorell device is reduced at

step 27, thereby causing a reduction in engine speed and engine load, is believed to be a misstatement of the operation of that device. Litorell states that at the entry into the process described by FIG. 2, the engine in operating in the stratified mode of operation. (Litorell, col. 8, lines 58-61.) During stratified operation or lean operation, "the engine torque depends only on the amount of fuel injected. Small changes in the amount of air do not affect the torque since there is already an excess of air." (Litorell, col. 8, lines 38-42.) We see in FIG. 2 that the Litorell device, once it has been determined in step 22 to switch mode of operation, has by step 27 calculated the lambda or fuel-air mix necessary to maintain the same "braked torque" required by the operation of the vehicle. We see that a primary facet of the Litorell invention, in fact, is performing the switch of operating mode without affecting the engine speed or load. (Litorell, col. 3, lines 11-26.) The adjustment of gas throttle in step 27 is related to changing the method of fuel control from nominal fuel control associated with stratified or lean operation to air-based fuel control associated with homogenous or comparatively fuel rich operation. (Litorell, col. 8, lines 22-35.) Therefore, applicants respectfully assert that Litorell does not disclose the features of this element of claim 10.

In light of the aforementioned distinguishing characteristics between Litorell invention and the present invention, applicants therefore respectfully assert that the disclosure of Litorell fail to teach every element of claim 10. In view of the remarks herein above, applicants respectfully request reconsideration of the rejection of claim 10 set forth in the subject Office Action and that same be withdrawn.

Claims 27-31 are rejected under 35 U.S.C. 102(e) as being anticipated by Litorell. These claims are ultimately dependent upon claim 1. In view of the traversal above respecting claim 1, applicants respectfully assert that the rejection of claims 27-31, these claims being dependent from claim 1, is moot and request withdrawal thereof.

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Claim Rejections – 35 U.S.C. 103

Claims 32 and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Litorell as applied to claims 31 and 1, respectively, in view of Ishii et al. USPA 2002/0029562 (*Ishii*). These claims are ultimately dependent upon claim 1. In view of the traversal above respecting claim 1, applicants respectfully assert that the rejection of claims 32 and 36, these claims being dependent from claim 1, is moot and request withdrawal thereof.

Claims 33 is rejected under 35 U.S.C. 103(a) as being unpatentable over Litorell as applied to claim 31 in view of Takeshima et al. USPN 5,437,153 (*Takeshima*). This claim is ultimately dependent upon claim 1. In view of the traversal above respecting claim 1, applicants respectfully assert that the rejection of claim 33, this claim being dependent from claim 1, is moot and request withdrawal thereof.

Claims 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Litorell as applied to claim 31. This claim is ultimately dependent upon claim 1. In view of the traversal above respecting claim 1, applicants respectfully assert that the rejection of claims 34, this claim being dependent from claim 1, is moot and request withdrawal thereof.

Claims 35 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Litorell as applied to claims 1 and 10, respectively, in view of Wachii et al. USPN 6,763,657 (*Wachii*). These claims are dependent upon claim 1 and claim 10, respectively. In view of the traversal above respecting claim 1, applicants respectfully assert that the rejection of claims 35 and 11, these claims being dependent from claims 35 and 11, is moot and request withdrawal thereof.

Claims 13 and 15-17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Litorell as applied to claim 10 in view of Takeshima. These claims are dependent upon claim 10. In view of the traversal above respecting claim 10, applicants respectfully assert that the rejection of claims 13 and 15-17, these claims being dependent from claim 10, is moot and request withdrawal thereof.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Litorell as applied to claim 13 in view of Takeshima, and further in view of Ishii. This claim is ultimately dependent upon claim 10. In view of the traversal above respecting claim 10, applicants respectfully assert that the rejection of claim 14, this claim being dependent from claim 10, is moot and request withdrawal thereof.

New Claims

New claims 37 and 38 have been added to more particularly point out and distinctly claim the subject matter of the invention. Specifically, claims 37 and 38 have been added to more particularly describe the recession of line 300 while defining the second region.

Applicants respectfully request consideration and allowance of these additional claims. No new matter has been added thereby. Each of the new claims 37 and 38 is ultimately dependent upon now allowable claim 1, with further limitation, and therefore allowable.

Allowable Subject Matter

Applicants wish to express appreciation to the Examiner for the consideration and allowance of claims 12 and 18. Applicants note that claim 18 stands as previously presented. Applicants further note that claim 12, rewritten in independent form, takes on all of the

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elements of claim 12, claim 11, and claim 10, as the dependency of claim 12 would have required. Claim 12 has subsequently been cancelled, and the independent form of claim 12 has been written as new claim 39. Therefore, claims 18 and 39 are believed to stand in condition for allowance.

Conclusion

Applicants believe that all claims 1, 10-11, 13-18, and 27-39 as amended are now in condition for allowance and respectfully request that they be allowed to proceed to issue.

The Examiner is encouraged to contact the undersigned attorney at the phone number appearing below if any questions remain subsequent to considering the present response.

Any fees associated with this response may be charged to General Motors Deposit Account No. 07-0960.

Respectfully submitted,

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